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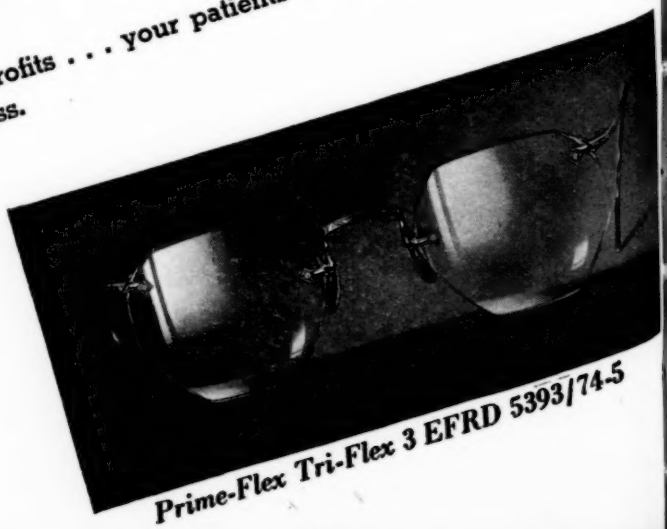

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AMERICAN JOURNAL OF OPTOMETRY

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GLAROMETRIC MEASUREMENTS ON OCULAR PHOTOSENSITIVITY*

Charles Sheard, Ph.D., D.Sc.
Division of Physics and Biophysical Research, The Mayo Clinic and The Mayo Foundation, Rochester, Minnesota.

Eyes are specialized organs of the body. Human beings are more than mere machines, for they experience fatigue and discomfort. Also, they have emotions and psychic reactions which determine their outlook and which govern their productiveness. They have eyes which vary in their ability to withstand abuses to which they may be subjected. Some people have eyes that can engage in the visual act under unfavorable conditions of lighting and under other untoward environmental surroundings with little discomfort. Other people possess eyes which show signs of fatigue under such conditions. There is also a third group of people who are made of such poor protoplasm or are so affected and incapacitated by disease that the ordinary, everyday surroundings of man in his workaday life produce responses and reactions which are not normal. So mankind in general, whether of good or poor protoplasm, is influenced by his surroundings. If these environmental conditions are favorable, man may carry on his work without undue inefficiency and discomfort.

Glare

The visual sense dominates behavior and is very definitely associated with usefulness and efficiency. Adequate and properly distributed light is essential for normal, efficient and comfortable vision since, as Luckiesh and Moss so concisely stated, "Light is a partner of vision in the achievement of seeing."

It is a well known fact that a bright light in the direct field of vision reduces retinal sensitivity and the visibility of objects in the field of vision. Everyday experience bears testimony to the truth of the statement that excessive illumination introduced into the visual field is, to say the least, a source of discomfort.

Glare may be defined as a brightness within the field of view of such an intensity as to cause discomfort and interference with vision. There are various degrees or qualities of glare: 1. *Veiling* glare is due to light, uniformly superimposed on the retinal image, which reduces contrast and, therefore, visibility. 2. *Dazzling* glare is due to adventitious

*Submitted for publication July 26, 1935.

light scattered in the ocular media so as to form part of the retinal image. This is the most common and also the most distressing type of glare. 3. *Blinding* or *scotomatic* glare is produced by light of sufficient intensity to reduce the sensitivity of the retina.

The definition of glare is essentially a description of a situation in which reduction of visibility or uncomfortable vision occurs rather than a precise statement of the nature of the phenomenon. This is dué to the fact that the effects of glare are stated chiefly in terms of sensation produced, are therefore subjective, vary with or are even variable in the individual, and are difficult of measurement. As a result, the effects produced by glare are quite definite in character but a quantitative measurement of them involves the inherent difficulties common to most measurements of human behavior.

Comments on the Determination of the Effects of Glare

In general, there are two methods which may be used for the determination of the effects of glare. In one of these methods, the subject of the test is placed in the situation to be investigated or under some arbitrarily devised set of conditions and is asked to report on the unpleasantness, discomfort or dazzle produced by the source of distribution of light employed. The second method consists in measuring, under various conditions of glare, the effects on sensitivity or acuity of vision and comparing the results of the tests with similar measurements when the source of glare is removed. Such procedures have the advantage of definiteness and, therefore, relative precision. It would be expected that the results obtained when the presence of glare is estimated from reports of discomfort would differ from those obtained from estimations and measurements of reduced visibility. A condition of glare that produces no detectable reduction in visibility of a standardized test object may be judged to be uncomfortable. However, a condition of quantity and distribution of light which produces a reduction in visibility is an unfavorable environmental condition for the eyes and is not conducive to general welfare, efficiency and comfort.

It is not within the purview of this essay to present a review of the salient features of the experimental work which has been done by various investigators concerning methods of measurement of and effects produced by glare. In passing, however, I desire to call attention to the contributions of Bell, Borschke, Clark, Cobb, Depène, Ferree and Rand, Livingston, Luckiesh and Moss, Nowakowski, and Sweet.

Purpose of the Investigation

The various investigations which have been carried out in the past with regard to the effects of glare, as expressed in terms of discomfort or reduced visibility, have been conducted as researches in illuminating engineering or as psychophysiologic studies. In general, the methods, experimental ensembles and technics of operation have been complicated. The investigations reported by me were conducted for the purpose of

adapting some simple system (as exists in the ensemble known as the glarometer) of varying the intensity of the environmental field in the direct line of vision to the measurement of the tolerance to light of a group of persons presumably normal in this respect and of a group of individuals who complained of sensitiveness to and discomfort produced by light. By such procedures it was hoped that a simple and definite method of measurement of tolerance to light could be established and that it would be possible, through the determination of the "glare-out" frequency distributions in normal and light-sensitive conditions, to obtain quantitative data which would be of value in knowledge of the physiology of vision and in clinical applications to persons who complained of intolerance of light under conditions which normally would not produce ocular discomfort or photophobia.

Apparatus and Method of Test

The apparatus used in the investigations reported in this article is known as the glarometer and was manufactured by the Glarometer Company, Chicago, Illinois. The instrument consists essentially of a variable resistance, *r*, (Fig. 1) joined in series with a 250 watt lamp, *s*, so ar-

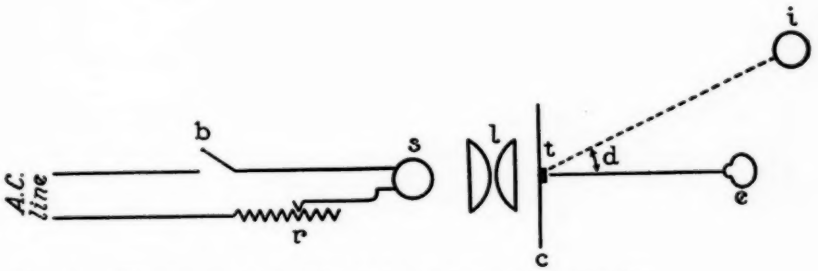


Fig. 1. Diagrammatic sketch of the experimental ensemble.

ranged that the illumination passing through a lens system, *l*, may be changed readily and progressively withmin a range of 15 to 1500 foot candles as measured by a photronic cell (in conjunction with a suitable multistage or combination ammeter) placed directly in contact with the glass screen, *c*, at its central portion. The screen, *c*, was a frosted or ground piece of plain glass which served as a diffusing medium. The ground glass screen carried a small target, *t*, made of cardboard which was just large enough to contain the word OUT in 8, 10 or 12 point Gothic letters. In general, 8 point letters were used, although numerous tests showed that the results concerning glare-out values were not affected by the size of the letters used. The fixation target was fastened to the side of the screen facing the observer, *e* (Fig. 1). The angle, *d*, formed by the line of intersection of the direct light from the source, *i*, on the target, *t*, and the line of the observer, *e*, was 27° 30′. The distance of the light source from the target and the value of the angle *d* were kept con-

stant. In all cases the eye of the observer was located in the horizontal plane of the target and 14 inches from the vertical plane of the target and glass filter.

The target, *t*, was illuminated by light from a 50-watt lamp, *i*, during the course of the experiments. The illumination on the target (6.4 foot candles) was determined by making readings with the photronic cell placed in the position ordinarily occupied by the target. (The readings of the current produced in the ammeter by the action of light on the photronic cell may be converted into foot candles by dividing the readings of the current in microamperes by 1.4.)

The illumination in foot candles in the environmental field of light (used for the production of invisibility of the letters on the fixation target) produced on the screen, *c*, by the 250 watt lamp, *s*, and the lens system, *l*, was determined by the ensemble consisting of the photronic cell and a combination ammeter. The readings on the scale (graduated from 0 to 95) attached to the glarometer were converted into equivalent readings of illumination in foot candles on the glass screen.

All persons who were tested were untrained observers. They possessed normal distant vision or, if not possessed of V=20/20, were given proper corrections. Presbyopes wore satisfactory reading lenses. Individuals with appreciable muscular imbalances were rejected.

In making tests on the glare-out values of the environmental field of light surrounding the fixation target, the intensity of illumination was slowly increased until the person under test reported inability to see the letters on the target. In general, three sets of readings (each set consisting of three determinations) were made and the average of these determinations taken as the glare-out values. A brief period of rest (3 to 5 minutes) was given between sets of observations.

Glare-out Determinations on a Group of Persons Presumably Normal in Tolerance to Light

Tests were made to determine the frequency distribution curve of glare values on a group of persons who evidenced no symptoms or complaints with reference to sensitiveness to light (photophobia). One hundred and thirteen individuals were examined for the glare-out values of the right eye and left eye respectively and 144 persons were tested binocularly. The results of these determinations, judged in units of 100 foot candles of environmental glare-out illumination, are given in Table I.

The three curves of Figure 2 show the relationship between the glare-out values in foot candles (abscissae) and the percentage of cases (ordinates) for each eye and both eyes respectively. It is evident that the majority of individuals have a higher glare-out value for binocular observations than when using either the right or left eye only. This would be expected on the basis of the summation theory (Helmholtz) and that binocular acuity is normally greater than the monocular value.

TABLE 1

Glare-out Values of the Illumination Measured at the Glass Diffusing Screen with 6.4 Foot Candles of Illumination on the Target (letters OUT)

Foot candles	Both Eyes		Right Eye		Left Eye	
	No. of cases	Per cent	No. of cases	Per cent	No. of cases	Per cent
0 to 100	1	0.7	0	0	0	0
101 to 200	10	7.9	20	17.7	40	35.4
201 to 300	40	27.7	42	37.2	35	39.8
301 to 400	35	24.3	25	22.1	13	11.5
401 to 500	23	16.0	17	15.1	9	7.8
501 to 600	22	15.3	5	4.4	4	3.5
601 to 700	6	4.2	3	2.6	1	0.9
701 to 800	4	2.8	1	0.8	1	0.9
801 to 900	1	0.7				
901 to 1000	1	0.7				
1001 to 1100	1	0.7				
	Total cases, 144; Average glare value, 380 foot candles		Total cases, 113; Average glare value, 295 foot candles		Total cases, 113; Average glare value, 240 foot candles	

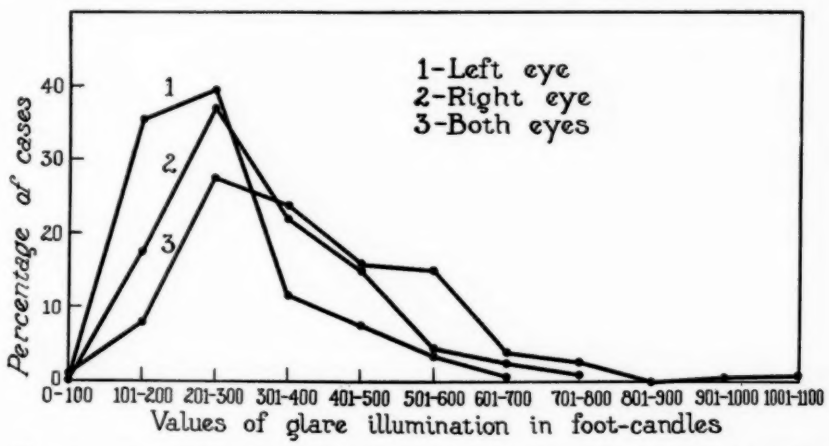


Fig. 2. Curves showing the frequency distribution of glare-out determinations on a group of 144 persons who did not complain of sensitiveness to, or ocular discomfort produced by, light under ordinary conditions.

Furthermore, the data indicate that the glare values are definitely higher for the right eye than for the left eye. It is possible that ocular dominance may serve as an explanation for this difference in glare-out values in the eyes when tested separately. Tests on ocular dominance showed that the right eye was the dominant (that is, fixating) eye in 73 per cent, the left eye in 20 per cent, and that there was no preference in this regard in

7 per cent. The dominant eye generally has a higher glare-out value than its mate, although this is not invariably the case.

In binocular tests the data show that the majority (more than 80 per cent) reported glare-out under illuminations ranging from 200 to 600 foot candles. More than 80 per cent reported glare with field illuminations ranging from 100 to 400 foot candles when the left eye was tested, and 94 per cent experienced glare with the right eye only under test with illuminations of 100 to 500 foot candles. The frequency distribution curves of Figure 2 for both the right and left eye respectively are shifted very definitely to lower values when compared with the values obtained with binocular observation. The average value of glare-out illumination was found to be 240 foot candles for the left eye, 295 foot candles for the right eye and 380 foot candles when both eyes viewed the target.

Effects of Absorptive Glasses on the Glare-out Values

In order to determine the effects of absorptive glasses, in which the absorption ranged from 14 to 45 per cent of the incident light, on the glare values, a series of tests was carried out on about 75 per cent of the group of persons who did not complain of discomfort or intolerance to light under ordinary conditions. Various absorptive filters were placed before the right eye, the left eye and both eyes respectively. Four grades of a tinted absorptive glass (designated as 1 to 4 in Figure 3) and two

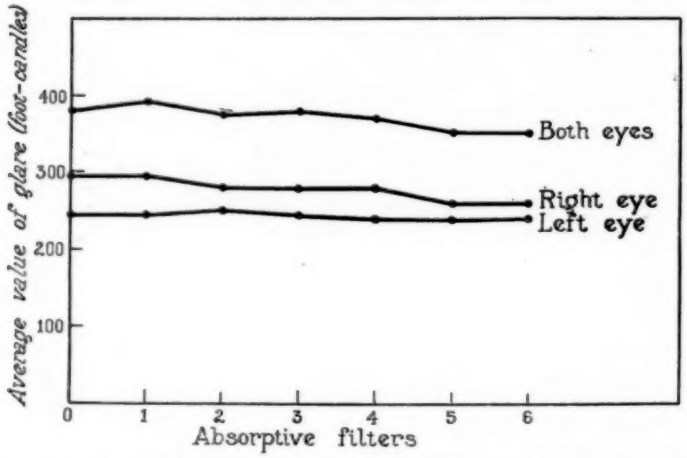


Fig. 3. Curves showing the effects of various absorptive filters on the glare-out values (average value in each group) obtained in normally light-sensitive individuals. (0—no filter; 1 to 4—neutral tinted glass; 5 and 6—smoke glass.)

grades of smoke glass (indicated by numbers 5 and 6) were used. The percentage absorption of incident light, determined from measurements with the photronic cell light-meter, of the four grades of tinted glass and

the two smoke glass filters were 14, 18, 23, 41, 35 and 45 respectively. In general, these glasses cut down the percentage of transmission of light quite uniformly through the range of the visible spectrum of 700 (red) to 500 (blue) millimicrons but showed an increasing absorption with decrease of wavelength in the region of 500 to 440 millimicrons.

The results obtained from the tests on 113 of the 144 persons who were examined are shown graphically in Figure 3. In the curves of this diagram, the ordinates represent the average values of the illumination producing glare and the abscissae indicate the various absorptive glasses used.

The experimental results substantiate the conclusion, previously reached in these investigations, that a higher value (foot candles) of the illumination was necessary to produce glare with binocular observations than in the case of either the right or left eye. Within the limits of error of the experimental procedures and apparatus, as well as the manner in which the data have been treated statistically, it is evident that the placement of various absorptive filters of the types used does not alter the values of the glare-out illumination provided the illumination on the letters of the target and the modus operandi of the tests are maintained constant. These results are to be explained on the basis that the light which is reflected by the target and which enters the eye (or eyes) is reduced in per cent the same as the light which enters the eye from the environmental (glare) field. Since it is known *a priori* that the ratio of the illuminations at the target and in the glare field is not altered by transmission through any given glass filter, it might be expected that no changes in the glare-out values would be produced by filters placed close to the eyes of the observer. These experimental results suggest the important conclusion that a condition of glare, in which there occurs invisibility of the object to which attention is directed, is not dependent on a definite number of foot candles per se. A condition of glare which produces invisibility of the object in an illuminated environmental field surrounding the object is dependent on the ratio between the number of foot candles in the environment field and the number of foot candles of illumination at the fixation target.

Effect of Changes of Illumination at the Fixation Object on the Illumination Necessary to Produce Glare

Since the experimental results showed that the placement of various absorptive glasses in front of the eyes did not affect, within the limits of experimental error, the values obtained for the illumination of the environmental field necessary to produce invisibility of the letters on the fixation target, it was of interest to determine the effects produced on the glare-out values by changing the illumination on the target. Determinations of glare-out illuminations were made when incandescent lamps rated at 25, 50, 75 and 100 watts respectively were placed in the same location with respect to the target and observer as is indicated in Figure

1. The experimental results for the group of individuals who did not complain of discomfort from or intolerance to light are summarized in Table 2.

TABLE 2

Effects of Changes in Illumination at the Fixation Target on the Glare-out Values of the Environmental Field

Rated wattage of lamp	Illumination, T, on target in foot candles	Glare-out values, G, in foot candles	Ratio $\frac{G}{T}$
25	3.05	125	41
50	6.4	272	42
75	8.6	390	45
100	12.4	520	42

The results of these tests show that the ratio between glare values (G) and target illumination (T) is a constant. From the standpoint of the physiology of vision it is evident that loss of visibility is dependent on the intrinsic brilliance of both the object viewed and of the surrounding background. The same fundamental principle has been used by Cobb, Sweet and others to determine glare effects. In general, these investigators introduced into the field of vision various sources of light which produced glare; the illumination on the target was increased until the letters could be seen and definitely differentiated.

The investigations concerning visual photosensitivity and glare values in exophthalmic goiter previous to and after thyroidectomy will be reported in a subsequent communication. In brief, these investigations show that individuals with exophthalmic goiter are, in general, more sensitive to light than the average individual who does not complain of sensitiveness to, or ocular discomfort produced by, light under ordinary conditions. Furthermore, the increased photosensitivity or decreased tolerance of light in exophthalmic goiter is not influenced by or dependent on the spectral character (quality) of light. A series of tests which were made on the group of individuals who possessed normal tolerance to light also indicated that there is no dependence of glare-out values on the quality of the illumination used in the glare field.

Summary and Conclusions

1. Tolerance to light in a group of individuals who did not complain of sensitiveness to and discomfort produced by light was investigated by glarometric methods, using an ensemble known as the glarometer.

2. In the group of individuals investigated, using an illumination of 6.4 foot candles as measured at the target, it was found that 85 per cent reported glare-out or invisibility of letters on the target with envir-

onmental (transmitted) illuminations ranging from 100 to 400 foot candles when the left eye was tested, 94 per cent experienced glare with fixation of the right eye under background illuminations of 100 to 500 foot candles, whereas under binocular test more than 80 per cent reported glare-out under illuminations of 100 to 600 foot candles. The average values of the glare-out illumination for the left eye were found to be 240 foot candles, 295 foot candles for the right eye and 380 foot candles under binocular test.

3. Glare-out values for 113 individuals were determined with a series of six neutral tint absorptive filters which reduced the intensity of the light (from both the target and the background) which entered the observer's eyes from 14 to 45 per cent respectively. The spectral character of the light transmitted by these absorptive filters was not appreciably affected. Within the limits of experimental error it was found that the placement of such absorptive filters before the eyes did not alter the values of the glare-out illumination in foot candles. This is to be explained on the basis that the ratio between the illumination on the target and in the background (glare) field was not altered by the use of absorptive filters.

4. The effects of changes of illumination, in foot candles, on the target carrying the fixated letters on the values of the glare-out illumination of the background were investigated. It was found that the ratio between the glare-out values and the illumination (3, 6.4, 8.6, and 12.4 candle power respectively) on the target was constant.

5. A series of tests was carried out on the group of persons normally sensitive to light using red, amber and green glass filters in the field employed for producing glare. The results of these tests indicate that there is little, if any, difference in the glare values which is dependent on the spectral character of the illumination employed in the glare field.

THE STEREOSCOPE*

Robert T. Best, Opt.D.
Fairmont, Minn.

The theory of Stereopsis, or binocular perception of depth, was correctly formulated by mathematics and later by pure logic long before the 19th century. The application of the laws of depth perception to his work contributed much to Da Vinci's fame as an artist in the 19th century. The principles of Binocular Vision, Stereoscopic appreciation of solidity, depth, and appreciation of different distances were understood long before the nerve distribution of the eye was discovered.

In 1838 Wheatstone supplied these principles and devised his instrument now called the Wheatstone Stereoscope. It is the mirror type now widely used in optometric instruments. Wheatstone explained the phenomenon of stereoscopic vision by the term "Retinal Rivalry." He was the first to advocate the theory of retinal rivalry.

In 1839, a few months after Wheatstone had introduced his stereoscope, Elliot invented the second type of stereoscope. This instrument was constructed without lenses, prisms or mirrors. It uses two small images and a septum. His object in introducing this instrument was to demonstrate how he was able to gain greater depth perception in landscape paintings.

The third type of stereoscope was introduced by Brewster in 1849, and was called the Brewster Stereoscope. This was a lenticular type stereoscope. In 1853 he published a true statement of the optical principles of this type of instrument. In brief, the laws for the making of any lenticular stereoscope, without exaggerated relief or disturbance of accommodation or convergence, are as follows:

1. The distance between the Optical Centers of the camera lenses and the viewing person must be the same.

2. The distance between the Optical Centers of the camera lenses and stereoscopic lenses must be the same.

3. The focal length of the camera lenses and stereoscopic lenses must be the same.

*An abridgment of the material presented before the Minnesota Academy of Optometry at Minneapolis, Minn., March 29, 1936.

4. The distance between the centers of the pictures must be the same as the distance between the stereoscopic lenses.

5. The pictures must be at the exact focal length of the stereoscopic lenses.

If all of the above rules are followed, there will be an exact reproduction of the distant object in stereopsis.

The objections to the Brewster stereoscope are as follows:

1. The size of picture is too small.

2. Uncorrected Hyperopes and Myopes are unable to get a clear picture.

3. Stereopsis for some people is difficult or impossible to obtain, due to faulty accommodation or convergence.

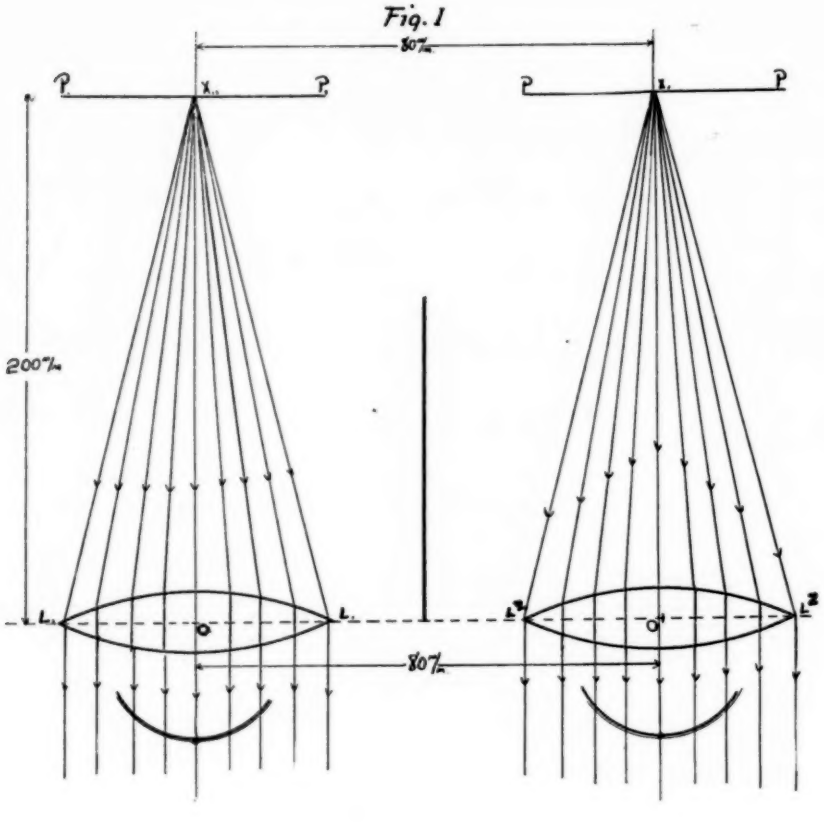
4. The P.D. of the viewing person is not the same in every case. There were a few more objections for the practical use of the stereoscope, but the above mentioned led to the further development of the Brewster stereoscope. About 1870 Sir Oliver Wendell Holmes modified the instrument by widening the P.D. of the lenticular system to 81 mm. This gave larger pictures. He added a movable picture slide so the pictures could be moved farther back or closer to the viewing person in the interest of Stereopsis and clear detail. A hood was added around the lenses and a septum installed between the lenses. This stereoscope became very popular and sold by the thousands. The name evolved to that of "Home Stereoscope."

Javal, Landolt, Hussman, Worth, Le Conte, Black, Wells, and many others devised training pictures for the phoria and duction tests at infinity, and also for orthoptic exercises. Some of these originated in France where the stereograms had a separation of 60 mm. and the training stereoscope also 60 mm. Some originated in Germany with a 63 or 64 P.D. Some originated in England where the P.D. was 81 to 75 mm. with some as small as 70 mm. Here the stereogram separation error became a fact. Some 60 mm. separated pictures were used in the Holmes Stereoscope with a lens separation of 81 mm. Some of the stereograms were 65 mm. and 72 mm. in center separation, but were used in stereoscopes with 81 mm. separations.

There are today stereograms for making phoria and duction tests whose centers are greater or less than the lens separation in the stereoscope. This is obviously incorrect and leads to incorrect conclusions.

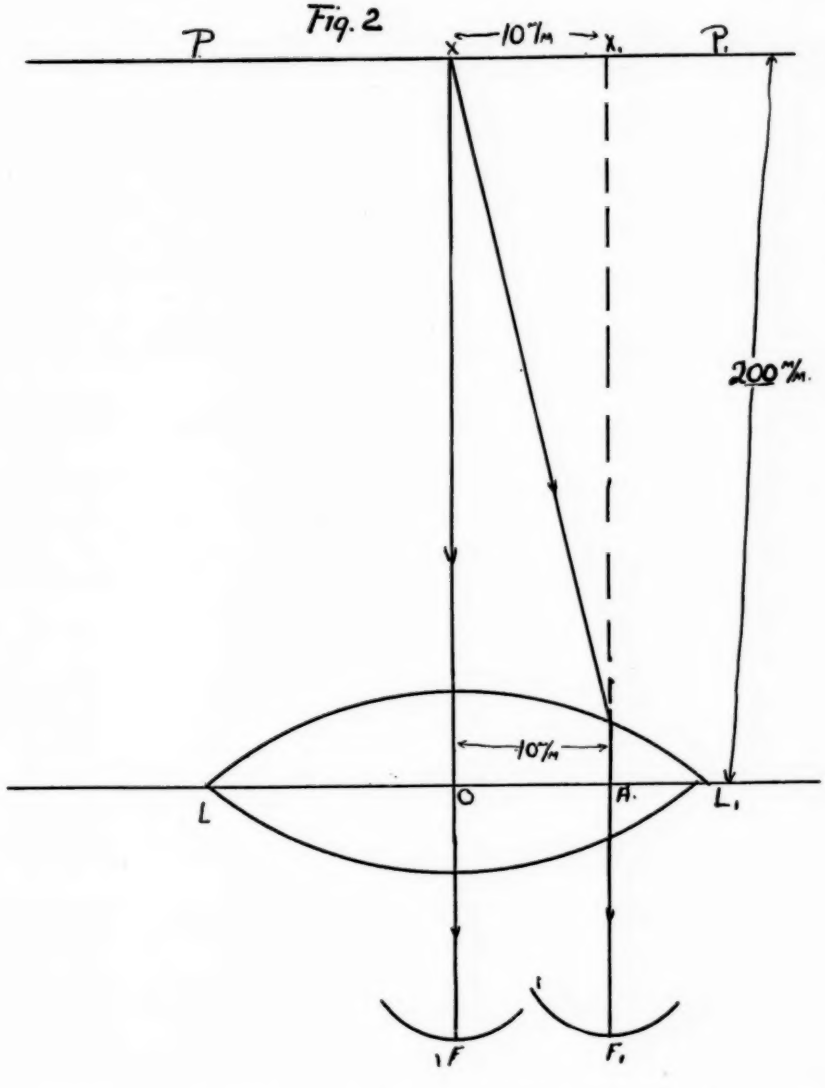
Holmes, by widening the P.D. of the lenticular system in the Brewster stereoscope, created in the minds of many the erroneous idea that he used prisms in combination with spheres. In fact, looking through the literature on this subject from 1920 to the present date, one is amazed at the number of optometrists and ophthalmologists that are firmly convinced of the prism effect in a stereoscope. Figure I is an Ortho stereoscope. Assuming, for simplicity, the patient has a P.D. of 80 mm., the pictures or stereograms are 80 mm. apart from their centers;

Fig. 1



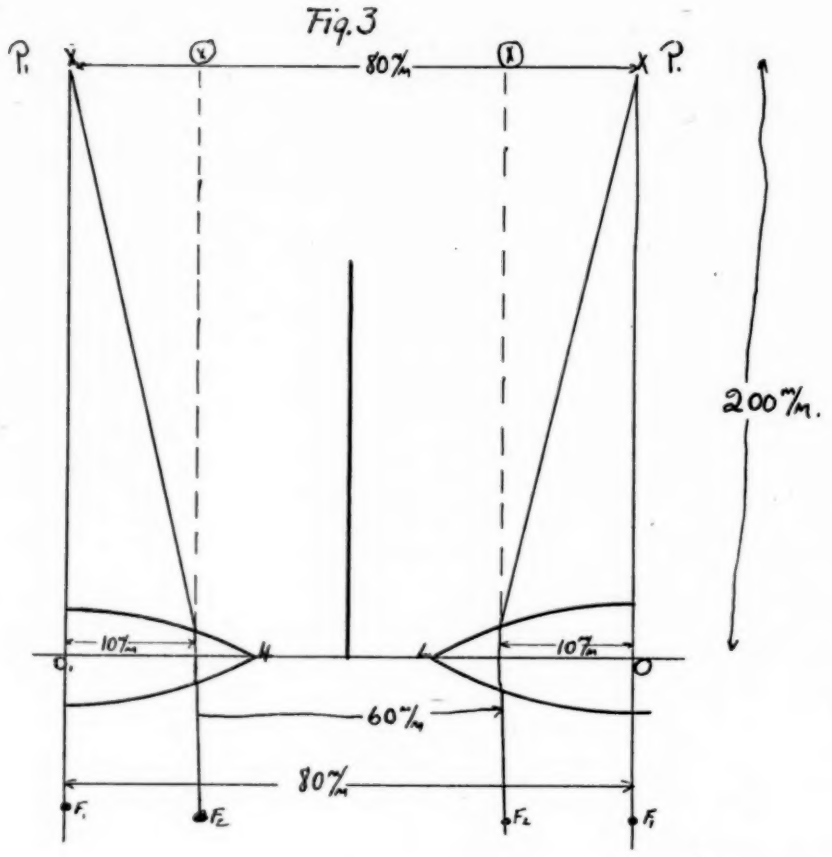
the lenses are plus 5.00, 80 mm. in P.D. and set at a distance of 200 mm. from the pictures. The centers of the pictures are situated on the optic axis of the lenses and at this exact focal length so that light is parallel on emergence from the lens. The lenses LL_1 and LL_2 are biconvex lenses 30 mm. in diameter and shown in the diagram as a complete lens. It is obvious there is no need for the total lens in any stereoscope, as the outer portions OL and OL_2 are not utilized. The manufacturers therefore split the lenses through the optical centers and used one on each side. The lens separation is measured from O to O^1. This splitting of the lens lead to the opinion that the stereoscope lens is a sphere plus prism which has a decidedly different effect than a spheroprism in a stereoscope.

Figure 2 is a diagram of a plus 5.00 lens (LL_1) at a distance of 200 mm. from a point image (X) on its principal axis or optical axis, (OX). F is the fovea of the observing eye and its projected image is at X. If the fovea F is moved 10 mm. from F to F_1 and views X, its projected image X displaced 10 mm. from X to Y_1. This does not necessi-



tate a change in the position of the visual axis from parallelism because the vision is along the axial ray to X. The conjugate foci of this lens are 200 mm. and infinity.

Figure 3 is a diagram of a one-dollar Holmes Stereoscope. I have been using this for some time. The observing patient (P.D. 80 mm. and emmetropic) whose visual axis are parallel and F_1 F_1 (his foveas) are on the principal axis of the lens, receives the two images X-X and projects along the axial ray F_1OX to X. There is no accommodation or convergence and the object is observed as if coming from infinity. F_2



and F_2 are the foveas of an observing patient whose P.D. is 60 mm. The images X-X are received parallel to the optical axis of the lens and projected back to (X)-(X). The image is displaced 10 mm. in each case, but still there has been no influence on accommodation or convergence, although he is looking through a spheroprism. If he had been looking through a sphere plus a prism, there would have been a disturbance of convergence. Also, if the objective points X-X were moved in or out, there would have been either positive or negative convergence exerted. I must condense this paper so I cannot take the time to demonstrate the image formation of a lens, prism, sphero-prism, or lens and prism, decentered or otherwise.

There should not be a great deal of confusion on the aforementioned, but I will read to you some excerpts from a few prominent optometrists and ophthalmologists on this point who have fallen into the error of calculating prism effect on convergence in a stereoscope with the principles of the stereoscope unviolated. The worst of these appeared

in the May, 1934 issue of the "Archives of Ophthalmology" written by Joseph I. Pascal, M.D., of New York. I quote, "To get the stereoscope vergence ,one must add the strength of the stereoscopic prisms used. When the ordinary hand-stereoscope is used, one must add plus 16.00 D. prism because of the O.U. 8 D. prism base out embodied in the instrument. Strictly speaking, the prism power in the ordinary stereoscope is not fixed, but depends on interpupillary distance. The prism effect is obtained from the decentration of the convex lenses used, which are O.U. plus 5.00. With the latter, a prism effect of 16.00 prisms is obtained for the average adult P.D. of 63 mm." This was under a table he devised for different P.D.s. Pine, in the "Optical Journal" of December and January 1933-34 used stereoscopes whose center separation was and is now in the Telebinocular series 4 mm. short of the stereoscope P.D. L. L. Beacher in the April, 1932, issue of the "American Journal of Optometry" states, "Each tube has a 5½ D. prism base out, making the optical system conform with the needs of a stereoscope." Guibor in the March, 1934, issue of the "Archives of Ophthalmology" uses the C series in the stereoscope, besides many other series—notably those devised and used by Worth, Le Conte, Von Graeffe, Wells, and others, each of whom revised the stereogram with a different print separation.

I am not inferring the stereoscope is not of value in orthoptic exercises or in taking the phoria and duction tests, but rather that the true principles of the stereoscope have been violated by, primarily, lack of study, and misinformation handed down by pseudo-intelligent salesmen on the subject of orthoptics. Briefly speaking, bad influences can be overcome by referring to the principles of construction for a stereoscope and measuring each instrument to see that no error has been made in the construction of both stereogram and stereoscope. Peckham has devised a simple formula and stop slide for use which must also be checked for accuracy because his work was also copied incorrectly. I have demonstrated the correct optical principles to be used in any stereoscope and stereogram. Due to one influence or combination of influences, mistakes have occurred in both instrument and stereogram. This has lead to false conclusions. Remember, the stereoscope is for use at infinity or within to 20 feet. It does not give near-point ductions, phorias, or orthoptic exercises. It can be used for near-point work, but to date the near principles for stereograms or stereoscopes have not been devised or used.

DR. ROBERT T. BEST
FAIRMONT, MINN.

THE CORRECTION OF AMBLYOPIA EX ANOPSIA*

William Smith, F.A.A.O.
Roxbury, Mass.

In training amblyopic eyes the resourcefulness and the ingenuity of the Orthoptist is of vital importance. There are numerous methods which have been tried from time to time and which have produced favorable results in the elimination of amblyopia ex-anopsia. In many instances, vision could be raised considerably, both for distance and for near and the visual function of the eye restored. There are, however, stubborn cases which will not respond to the routine methods of training. By the routine methods, we mean total occlusion of the good eye, the use of the affected eye for work at the near point, and its use in reading Snellen letters and other objects at distance. There are numerous cases, especially those in which vision in the amblyopic eye is reduced to light perception, finger counting, or even the very low Snellen notations, such as 1/200 or 1/300 or 1/400, in which occlusion of the good eye cannot be tolerated, first, because such procedure would render the patient nearly blind, and second, because it would subject the patient to possible injury, due to lack of the ability to see. In such instances, it is necessary to start the patient off with even more elementary methods than those outlined. While we concede the value of total occlusion, either with an eye patch or with a frosted blank, such procedure may often be deferred—of necessity—to some later period. The training of such eyes must commence with the steps where nature left off.

When we speak of amblyopia ex-anopsia, we have in mind a condition of low visual perception due to the insensitiveness of the receptive and the transmitting fibres of the affected eye. An ophthalmoscopic examination of an amblyopic fundus will not disclose anything abnormal either in the macula or in the disc. The fundus has all the appearance of a normal one. Whatever abnormality exists is in the visual centers of the brain.

It is interesting to note how the apparatus of binocular vision is functioning in the normal state. Briefly, it may be stated that the apparatus of binocular vision is described as a reflex arc made up of a centripetal path, a cerebral center, and a centrifugal path.

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The centripetal path is purely sensory. Müller has advanced the theory of corresponding retinal points which states that there is a coupling of the retinal points in the right retina with the corresponding retinal points in the left retina. The fovea and its immediate area have their own path of distinct conduction.

Insofar as the fovea is concerned, the fact is certain. Pathology, embryology and physiology all prove the individuality of the papillomacular bundle. There is, however, no absolute need for a rigorous anatomical coupling. Such a coupling may only be physiological and yet quite sufficient. Starting from corresponding points in the two retinae, the image of the right eye and that of the left eye are propagated towards the cerebral center, and obviously, in order that the two images may be fused, the two paths must meet. The arrangement of the visual path, the decussation of the bundles proceeding from each half of the retina are too lengthy to be discussed here. At the very beginning of each optic tract a fibre from one-half of the retina meets with the corresponding fibres of the other side, and a more perfect union of the corresponding fibres takes place in the ganglia at the base of the brain and what travels from there to the cerebral center is really a resultant.

From the foregoing it is to be surmised that a clear pathway must exist for the conveyance of the external impulse which reaches the retinae. The image is carried along the optic tracts to its corresponding brain center. Any interference, whether mechanical, physical, pathological or psychic, will prevent the act from being completed with the result that there is confusion. This is precisely what happens before amblyopia-exanopsia occurs. It begins with a feeling or a sensation of confusion; then in some cases it is manifested by inco-ordination and diplopia. To simplify matters, suppression is resorted to and gradually the visual center builds up a defense against this constant interference and confusion. It develops an area in which the bothersome images are ignored and then suppressed altogether. In time, a definite area, described as the suppression area, becomes developed and the pathway of conductivity becomes dulled, obscured, and obliterated.

All this has its beginning in some form of heterotropia either constant or periodic. In the periodic types the danger for the acquisition of amblyopia ex-anopisa is not so great as in the constant types. But any periodic strabismus may turn into a constant type and the consequences which may follow are too well known to be repeated. Amblyopia ex-anopsia follows in all such cases. The visual centers in the brain which are related to the affected eye soon learn to ignore the confusing image and gradually the eye learns that it can forget how to see and yet remain open.

The first step in the training of amblyopia ex-anopsia consists of developing visual perception and orientation. When the eye "learns" to appreciate objects, forms, and colors, actual training commences.

It has been our experience to observe results in a good number of cases by following the routine which we are to describe in detail. In the course of this description, we shall make reference to contrivances which we made up and which we found very beneficial in the training procedure.

The importance of the elimination of suppression is of paramount importance in the development of amblyopia ex-anopsia. To accomplish this it is often necessary to invent methods and procedures.

In our routine of training, we tried a procedure advocated by others. Light stimulation has long been recognized as a valuable adjunct in the training of the retina. Most orthoptists use an ordinary table lamp or a wall bracket lamp and flash the light into the patient's eye either with a flasher or by flashing it off and on, manually. This procedure we found unsatisfactory. In the first place, too much light was wasted. In the second place, the patient had to retain a certain position in order to have the light fall on the macular area in the retina. In the process of searching for a better means, we hit upon the idea of constructing a stimulator by using a small metal can. This we wired and set in front of the telebinocular, between the card holder and the instrument. This produces a dark chamber for light flashing and the patient sitting in front of the instrument receives the light directly in the macular area. The other eye is occluded. A variation of this training consists of using a card with some object, such as a postage stamp or a letter, or a group of letters, in front of the eye that is not being stimulated. The stimulator flashes light into the amblyopic eye, and during these flashes, the patient is able to see both the light, and the letters on the card simultaneously. His attention is directed to the position of the light on the picture or leters. As simultaneous fixation becomes apparent, the patient will see the light placed over the picture in front of the good eye. This is an excellent step in the training of binocular perception. We have constructed, for our own use, a retinal stimulator which can be used independently. We used corrugated cardboard, from which we constructed two tubes set on a pedestal at an incline of about 45 degrees. These tubes are joined together and are wired with candelabra-type sockets. We used a pair of flashlight reflectors. The socket and reflector were mounted on blocks of wood and wired. In front of the bulb, on top of each tube, we made slits into which are inserted filters, occlusion discs, or other devices which are considered necessary in the course of training. Retinal stimulation with light is continued over a long period. We give this form of training from the very outset. At first, the patient does not seem to show any ill effect, but as training progresses and vision becomes developed, the length of time used at first is no longer tolerated. The patient begins to report that he "feels the light," and after a while, light stimulation becomes intolerable. It is at this time that light stimulation be discontinued.

Visual acuity training, by using various types of cards or any other device which the orthoptist may find most practical, as well as handy, should be given in conjunction with light stimulation and should be

continued after light flashing is discontinued. The orthoptist will find that the amblyope, especially the one with very low visual acuity, has poor projection. Oftentimes, this mal-projection extends over an area of ten to fifteen degrees from the original source. Projection training is the first step. This training should be given in conjunction with light stimulation and visual acuity training, when that is possible.

For the training of projection, many methods are available. Some use newspaper type around which they have the patient draw circles, and trace. This tends to develop macular fixation and projection, but the average patient finds this work rather tedious and exceptionally uninteresting, and tries to shirk it as much as possible. To overcome this, we constructed a series of plates drawn free hand. The pictures consist of objects with which most patients are familiar, such as animals, toys, houses, etc. Holes are punctured in these pictures and the patient is instructed to insert a colored toothpick into them. The good eye is occluded and projection, as well as macular fixation, is trained in a manner most appealing to the patient. The patient is not to feel or search for the hole. He is to insert the toothpick by actual observation and perception.

To keep vigilance over the patient's progress, we use a small hand mirror placed in front of the patient and in such a way that we can watch his eye, hand and his entire action without him being conscious of it. We make corrections whenever necessary. We check progress on a series of plates which we made for the purpose. These consist of block letters, pictures, etc., which the patient is required to outline periodically. We find that by this method macular fixation and projection are fully developed in a much shorter time. In addition, by giving light stimulation, the suppression area in the visual centers is cleared up and this method tends to develop a reflex arc which is ready for the second step in the training of amblyopia ex-anopsia.

The patient is now ready for the coordinate use of the eyes. It would be folly to start him on fusion training before getting him used to the new environment. Binocular vision is a habit and a function of which the strabismus patient is not aware. He has learned to suppress in order to avoid diplopia and discomfort. By restoring the reflex arc, he is ready to receive impressions in both visual centers. But, the tempo of his two eyes has been unequalized over the period of the existing strabismus and the period of amblyopia with its suppression area. By clearing up the reflex arc, we have not re-established equality in the perception of the two images and the amblyopic eye lags behind. The next step is to establish co-ordinate perception.

To attain this end, our system, of which projection and check plates are a part, contains a series of poems, short stories, fables and fairy tales, printed in orange and black and arranged in Jaeger test type sizes from No. 20 to No. 1, respectively. In the smaller type letters, longer stories are used, some of which we composed. Coordinate use of the eyes is again checked by a system of stories which we call "Right and Left Suppression

Training and Alternating Suppression Training." In these series, the stories are written in Jaeger No. 2, 4, 6 and 8 type, and is small enough to permit easy reading. In the series used for coordinate training, as in the check series, a ruby filter is used over the better eye. This filters out the orange, making it visible only to the amblyopic eye. The better eye is seeing the black letters; the poorer eye is seeing the black and the orange letters. In this way, both eyes participate in the act of co-ordinate vision and the visual apparatus is getting prepared for the act of binocular vision. The check series puts more work on the amblyopic eye. The better eye gets the start in the act of binocular vision, but this task is soon taken over by the poorer eye and again resumed by the better. In this way, the orthoptist is kept informed as to whether or not there is suppression.

By this combination of methods, we have succeeded in eliminating suppression, re-sensitizing the macular area and thus establishing the reflex arc of binocular vision. By the use of an ingenious system, we have established projection and macular fixation. The two eyes are yoked together as a unit by the use of our amblyopia training book with the two color letters, the largest of which are visible even to the amblyope with finger counting vision. In addition, we have plates, for visual orientation. These consist of pictures with which everyone is familiar and which are shown to the amblyopic eye for recognition and description. Our object is to establish a feeling for seeing and to put the eye into a state of reception. Each system is carried to the utmost point of development and care is taken to obviate malingering and memorizing by the numerous check tests provided.

With projection established, visual acuity training is continued by using various methods and techniques. It is advisable to continue this procedure throughout the entire system of training, even during the period of fusion and duction development. This helps to keep the reflex arc clear and to obviate a relapse of suppression. By the use of the amblyopia training book, it is often possible to bring about the establishment of diplopia. When this is accomplished, the patient is ready for the training of fusion.

It is imperative in the training of strabismus to eliminate suppression entirely, to re-establish projection and to develop the sensitivity of the macular area. It is doubtful whether or not there is such a thing as a "false macula." It is more likely that the strabismic patient has abandoned all hope of ever seeing with the deviating eye and all vision that is registered in that eye is registered on the peripheral portion of the retina and no definite area is visible with the microscope or ophthalmoscope. The macula even in the amblyopic eye has its distinct anatomical position.

Proper development of amblyopia is the first step towards the successful conclusion of a strabismus case. Care, therefore, must be exercised to re-establish sensitive perception of visual impressions in the area

which is naturally designed for that purpose. Every resourcefulness and ingenuity must be utilized to attain this end.

DR. WILLIAM SMITH, F.A.A.O.
260 SEAVER STREET
ROXBURY, MASS.

OCULAR FUNCTIONAL ABNORMALITIES— A CASE REPORT*

Jack I. Kurtz, B.Sc., A.O., M.A., F.A.A.O.
Minneapolis, Minn.

The two outstanding concepts of abnormality today are: (a) The organic, (b) the functional. The advocates of the organic concept claim that each abnormality is caused by a definite injury to the nervous material, therefore in an abnormal condition one must always look for a physical disturbance of the nervous tissue. They also contend that even if we fail to find the destroyed tissue it is simply due to our lack of sensitive diagnostic instruments, fine technic, etc., but it does not mean that a condition of destroyed tissue is not there.

The functionalists do not deny that a diseased or broken down nervous system will fail to function normally; they do, however, insist that the failure of a complex machine to function properly may be due to some lack of adjustment between parts that are intact. Improper function, they hold, may be the cause of organic and diseased conditions just as diseased conditions may cause abnormal function.

Many clinical investigators had occasion to observe ocular conditions which were caused by functional abnormalities. Dr. Uddgren of Sweden, speaking before the Medical Women's International Association at Bologne, Italy, at the 1928 Congress, presented some interesting data concerning the effects of functional abnormalities and general bodily illness on the refractive condition of the eyes. Dr. Uddgren reported cases of children who had a visual acuity of 20/100 or less in which the sight was restored to normal by using purely psychological methods.

During the last fifteen years I had occasion to observe clinically a number of cases which may be classified as functional ocular abnormalities. The following case is a clear illustration of this type:

Miss H. A., age eleven—The child appeared to be well developed for her age. The chief complaint was that the child could not see to read and was thus unable to do her school work. This condition came on suddenly in the spring of 1933. She was refracted on several occasions with and without the use of a cycloplegic but none of the refractionists pre-

*An abridgement of the material presented before the American Academy of Optometry, Cleveland, Ohio, December 17, 1934.

scribed lenses, as these were of no help. The parents were advised to keep the child out of school for the remainder of the school term, with the ultimate hope that with rest and nature's assistance, the condition might be rectified by the time the school would open in the fall. However, the condition did not improve and the child still had the same trouble. One of the refractionists advised a thorough physical examination. This was made during the month of October by a very competent examiner at one of the clinics, amongst other things it included a blood test, urine, spinal fluid, X-ray, etc., all of which proved to be negative. The parents were then advised to place the child in an hospital for some time for study and observation. They did not follow this advice, and on November 7, 1934, the child was brought to our office.

Examination—External ocular examination negative, fundus negative, light reflex negative, accommodative reflex positive. The pupils were very large and contracted very good to light, but none at all to accommodation.

Static retinoscopy, OD + 0.75 D.S.; O.S. + 1.25 D.S.
Dynamic retinoscopy, O.D. + 3.00 D.S.; O.S. + 3.25 D.S.
V.A. without lenses 20/20 O.U.
Subjective O.U. + 0.25 D.S. O.U. V.A. = 20/20.
6△ Es. at distance and 10△ at near. No vertical imbalance.

Adduction, abduction and positive and negative reserve fusion convergence were normal. These findings were very constant upon three examinations on three different days. While her visual acuity for distance was quite normal, at near she could only read with difficulty the largest size of type on the near-point test card. Plus lenses did not improve her reading ability in any way. I was suspecting that she was malingering and a number of very exhaustive malingering tests were performed. These tests proved to my satisfaction that she was not malingering.

I next tried the Freudian talking method. The child alone was taken into the examining room. The parents remained in the waiting room. I engaged the child in a conversation along different lines, by using a number of selected questions I was able to direct the conversation along certain channels. This yielded desirable information. At one point the child informed us that last spring her teacher gave her a "terrible scolding in front of the entire class. Since then the children in her room were poking fun at her." She never felt comfortable in class and always wished she could get away from there. As she related this experience to me, I could notice a complete change in her facial expression. Her childish, happy expression left her suddenly and one of grief, worry, and fear took its place. Her eyes looked dull and staring. At this point I interrupted her conversation and said, authoritatively, we can fix this matter for you easily enough. We can get you transferred to another school or else we can get you transferred to another room in the same school. Like a flash her former happy expression reappeared, and now I said that now as you will have a different teacher, I also want you to be able

to read as well as any child, and I am going to fix a pair of glasses for you which will enable you to read as good and even better than you ever did in your life. At this point I placed on her the trial frame with a pair of plano lenses, handed her a book and told her to read. At my great surprise she read very fine print for about forty minutes. Her accommodative reflex *now reacted negative*. On the next day she read with comfort for nearly two hours. I then called in the parents and showed them how well the child could read. I gave them this prescription—O.D. + 0.75 D.S. O.S. + 1.00 D.S. This was made up in a Crookes A.

I instructed the parents what to do regarding the transferring her to another class and asked them to keep me informed as to how she is getting along. Three weeks later I was informed that the child is going to school and is doing well.

Now all this may sound like a fairy tale to some of you, but to me it seems to be a definite functional abnormality which was caused by an emotional complex of fear and worry.

That this was a functional abnormality we have these criteria:

1. There was no pathology found after the most exhaustive physical examinations, and lenses were of no help.

2. That the pupil which did not at first react to accommodation suddenly gave a negative reaction as soon as she began to read.

3. This condition came on suddenly just as it disappeared suddenly.

4. From the signs and symptoms it can be seen that this was not a case of structural abnormality, but rather a case of impaired function.

Differential Diagnosis

To help differentiate between organic and functional disorders, Professor Hollingworth gives these general signs:

1. There is an intermission of symptoms in function cases while in organic they are constant.

2. Organic conditions are staple and invariable and go through a definite course of development. Functional conditions may show extreme variability in character and in intensity.

3. Functional symptoms are more likely to be found amenable to the devices of psychotherapy, to suggestion, threats and distractions, but truly organic conditions will not yield to any such agents.

4. Organic symptoms are easily assignable to specifically located lesions. Functional symptoms do not lend themselves to this topographic exactitude.

5. Organic conditions usually obey the laws of physical cause and effect and functional symptoms do not obey these laws and are easily manipulated by trick examination so that many observers are inclined to take them to be malingering.

There are a number of other signs usually employed during an examination in order to determine whether a paralysis for instance is of a functional nature. When movements are made or attempted with a paralyzed member, associated movements are more likely to appear in organic conditions and to be absent when the paralysis is of a functional nature.

DR. J. I. KURTZ
1501 FOSHAY TOWER
MINNEAPOLIS, MINN.

DISCUSSION

DR. BEITEL: Mr. Chairman, I should like to compliment Dr. Kurtz on the insight he seems to possess in this type of case. While in strict scientific psychology psyhco-analysis is looked upon rather dubiously by some workers because the basic physiologic mechanisms are not understood, the facts are there, and in treatment results are obtained. What brings them about, however, is not exactly known.

DR. WILLIAM TAIT: Dr. Kurtz's case could possibly be explained on the basis of the concept developed quite a number of years ago by Adler. He claimed that all neuroses and all the psychic disturbances and abnormalities were the result of development in the individual of an inferiority complex. Surely this child developed an inferiority as a result of her classmates' ridicule. I have observed in quite a number of my squint cases that there are personality and maladjustment cases, and that point has to be taken into consideration. They are not normal cases as far as their mental makeup is concerned. I think that if Dr. Adler were living today he could very easily explain the case on that basis, that the child did develop an inferiority complex and that in some unknown fashion inhibited the impulses coming down from the higher centers, and that would prevent the accommodation coming into play.

A STUDY OF VISUAL REHABILITATION AFTER 30 YEARS OF BRAILLE*

William Feinbloom, M.A., D.O.S., F.A.A.O.
Research Fellow, A.A.O., Columbia University
New York, N. Y.

All the problems of visual rehabilitation we previously enumerated, and many new ones, were encountered in this case study. The question is always asked as to what is the least vision a patient must have before rehabilitation is possible. Our only answer can be reports such as this, where we start with vision so low that it cannot be measured, and after considerable research, develop a lens that seemingly performs the impossible.

The subject, Mr. I. C., is now 46 years of age, white, married, and in good physical health. He was first seen on January 16, 1933, after a friend of his had read of the development of the new Sub-Normal vision lens in the newspaper.

Examination at the first visit disclosed that the patient had been born with normal eyes. He had no difficulty with his vision until his sixth year of age. At that time, he had just been entered in his second grade at school. He had just learned the letters of the printed alphabet. A series of infectious childhood diseases, diphtheria, scarlet fever and whooping cough, resulted at this time in an infection of the ocular and bulbar conjunctiva, with consequent clouding of the cornea.

The boy recovered his health but, as occasionally happens, his sight remained poor. The vision was too poor to continue at school. A series of ophthalmological consultations ensued until the renowned Professor Knapp advised surgical interference, iridectomies to provide new pupils. The patient, then a boy of 9, was operated on in both eyes and was totally blinded.

Mr. C. remained totally blind for three years. He could neither move about alone, nor distinguish anything but bright sunlight. At this time, further surgical work was undertaken. The right eye underwent twelve separate operations, and the left eye some twenty operations. The final result left the eyes as they were seen on the first visit.

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*An abridgement of the material presented before the American Academy of Optometry, at New York, N. Y., August 25, 1935.

Mr. C.'s vision at the age of 14 permitted him to walk about with care. He could distinguish moving objects from stationary ones, but could not distinguish the objects themselves. He would cross streets by waiting for a crowd of people and then cross with them.

He was admitted to the N. Y. Institute for the Education of the Blind at the age of 14. His formal education, which had ceased at the age of 6 years, was now started again. At the Institute, all his work was carried on through Braille, the touch finger system. He continued his studies here, under excellent supervision, until he was twenty years of age, when he was graduated. He entered Brooklyn Law School one year later. He did all his work here through a paid reader. He committed to memory all the necessary material, so that in two years he was graduated with honors. He was admitted to the Bar the following year. Mr. C. has continued in his practice of law for 25 years. His work before the Bar is well known.

Optometric examination at the time of his first visit showed:

Ophthalmoscope and Slit Lamp:

Right eye: Pannus over most of cornea, deep corneal scars and leukoma, old iritis, anterior synechia, atrophy of iris, complete cataracts. Pupils pinpoint, no view of fundus possible.

Left eye: Pannus over most of cornea, not as dense as right eye, deep and superficial corneal opacities, anterior polar cataract, anterior synechia and atrophy of iris—iridectomy at 90°.

Vision:

Right eye: No light perception of 500 watt bulb.

Left eye: Light perception within field of approximately 30 degrees, movement perception but no form perception. Could not distinguish a 20/1000 foot circle at a distance of 2 feet.

Eye Movements:

The patient had bilateral nystagmus, vertical and rotary. These were frequently interrupted to yield to "searching movements," typical of the totally blind. Mr. C. always appeared to be looking at the ceiling. His projection was extremely faulty.

Further examination with lenses of all types, Contact Lenses for corneal irregularities, Telescopic Lenses, etc., gave no evidence of form vision. Patient advised to wait six months before further examination.

Six months later, patient recalled, and condition the same as before. Again examination showed no measurable vision, and lenses did not seem to help. However, at this visit, which lasted about four hours, the patient seemed to respond better. His projection to lights was better. He was advised to wait until further research might yield more suitable methods and lenses.

The patient was again recalled in November, 1934. By this time, we had developed in experimental form a 3.5x Telescopic Spectacle. Examination with this lens gave some evidence of a high refractive error. With correction and Telescopic Lens, the patient showed some evidence of form perception. He could, for example, describe the 20/1000 letter "O" at 4 feet as something that was not square but rather round.

Examination with Telescopic Lenses gave findings which were prescribed for constant use for the next three weeks.

Rx: R. to match
L. +6.00 D.C. x 90⌒4△ base up.

Examination on December 8, 1934, permitted, for the first time, some estimation of the patient's vision. It must be remembered that Mr. C. had no visual pictures of either letters or numbers. At this stage, we could only expect him to describe the general form of letters he could see. The refraction at this time was changed to:

O.S. +3.50 +6.00 x 90⌒8△ base up.

A course of visual instruction was then inaugurated with the patient reporting at the office an average of 10 hours each week. This was maintained for six months and then, except for vacation time, visual instruction in reading and writing was continued to the time of this meeting for five hours each week.

His progress at first was infinitely slow. The first few weeks were spent in teaching him the alphabet. We used picture books where each letter was two inches tall. This preliminary work is done with a Microscopic Spectacle of 12x.

Following this alphabet work, short words were introduced through the medium of "flash card" drill. All the letters were printed. At the end of the first month, the patient was reading from a "1A" reader. He was now using a Microscopic Spectacle of 16x.

Frequent check of the patient's visual acuity finally showed on February 21, 1935:

O.S. +3.50+6.00 x 90⌒8△ up⌒2.2x T.S. to 5/175 and,
O.S. +3.50+6.00 x 90⌒8△ up⌒3.5x T.S. to 10/200

During all this time it was evident that our existing form of lenses would not enable the patient to read No. 5F, i.e., newspaper print, on the Sub-Normal Vision reading card. Some other method had to be found to increase his visual acuity for near.

We therefore set ourselves:

THE PROBLEM

To design an optical system of from twenty to twenty-five magnification that could be used as a spectacle for reading.

THE SOLUTION OF THE PROBLEM

The solution finally arrived at is this new Micro-vision Spectacle. Our experiments, which were conducted for over a year, started with an investigation of the theoretical limits of the magnifying power of our previously designed Microscopic Spectacle. We found, however, that it was not possible to obtain the necessary magnification and still retain a useful field and working distance if the magnification were increased beyond 17½x. A mechanical photographic set up was then used in order to study the effects on an optical image that was formed through cloudy media, and poorly grained plates. This same photographic apparatus was used to take photographs through various magnifying systems. What we were concerned with was what happened to the blur of the original image, as the image itself was magnified.

The human retina responds in many ways like a photographic plate. Certain differences which account for the relation of visual acuity to the intensity of illumination permits a determination of the elements in the retina and optic nerve, which are functioning as compared to those which are atrophied.

Thus, as in Mr. I. C.'s case, where it was not possible to take a central field test, it was possible, by obtaining his curve giving the relation of visual acuity to intensity of illumination, to determine the probable dstribution of his useful rods and cones.

A second observation that pointed to the right line of research was that previously made on a number of subjects. These were people who could not read with ordinary glasses at the usual reading distance, yet could read well if they held the paper one or two inches from their eyes. This meant, of course, that they were using their own eye as a magnify-glass. It is true that the image under such conditions is not as well defined as under more normal conditions of reading. However, our experiments with the photographic plate had showed us that this blur was not nearly as bad as one might suppose from strictly geometrical theory.

We finally arrived at the idea of designing an optical system that would itself have magnifying power and at the same time would add to it the magnifying power of the eye.

The optical principle evolved that would permit this to occur may be stated thus: The emerging light from the optical system must be highly divergent, in contrast to a microscopic system where it is parallel. The incident light on the optical system will necessarily be highly divergent. The necessary condition that the divergent incident light leave the system as divergent light, is that the object plane of the system be inside the focal plane. The actual form of the Micro-vision Spectacle is two lens systems separated by 0.5 cm. The size of the apertures of both objective and ocular is sufficient to insure a useful working field. The working distance is approximately one centimeter.

In its present form, the Micro-vision Spectacle has an angular field of about half a newspaper column; the magnification is 23 times.

While these experiments were going on, Mr. C.'s visual education was progressing. On March 19, 1935 the patient was given a special type of preliminary viewing spectacle, to permit him to read the large print in the newspapers.

Rx: O.S. +25.00 +6.00 x 90°⌒8△ up.

This lens he used for several hours each day at the office and at home. It was important that the patient become familiar with the different forms of type used in headlines, sub-headlines, advertising, books, etc. The patient's rate of reading, while still slow, was definitely increasing

At the beginning of May, Mr. C. was introduced to script, letters and words. He took to this readily. His instruction in writing was then begun. His progress in writing was extremely slow. The necessary coordination between eye and hand required a long training period. To date, his writing is still poor, but it is only a matter of further practice before he forms his letters well.

Summary and Conclusion

The subject here presented, Mr. I. C., marks a new lower limit as to those cases possible of rehabilitation. When first seen, he had no measurable visual acuity, certainly less than two per cent. His case is typical of more than half of the persons confined in blind institutions. We have had a number of such subjects, originally trained in Braille, who are now in normal public schools, high schools and colleges. It will be possible through the use of this Micro-vision Lens to aid many of the extreme near-blind cases who could not be aided before.

The time and patience necessary for such rehabilitation requires that the doctor properly prepare himself for this work.

The improvement from an unmeasurable amount of vision at the beginning of the work with Mr. C., to his present ten per cent with spectacles, is due to practice in visual perception.

DR. WILLIAM FEINBLOOM
138 E. 36TH ST.
NEW YORK, N. Y.

DISCUSSION

DR. J. C. NEILL: Lacking the experience which Dr. Feinbloom has had in sub-normal vision work, I have, nevertheless, noted a few points about which I should like to speak. One statement made in the beginning of Dr. Feinbloom's paper should be emphasized, that is the one concerning the lack of any definite method of indicating the visual acuity of these cases. It is very difficult to conceive of 2/1000 or 4/1000 vision

and to further appreciate that a patient with such visual acuity seems to be able to walk about streets crowded with traffic and do many other seemingly impossible visual tasks. So, I should like to see developed some means of indicating visual efficiency rather than visual acuity in these cases.

Where the sub-normal vision is due to a central scotoma resulting from a central fundus lesion, it is apparent that the actual optical enlargement of the retinal image must be great enough to carry over into the intact areas on either side of the lesion in order to have the true visual axis form the line of fixation. A greater lesion would require a new visual line ending at an intact area entirely to one side of the lesion and thus the patient would apparently squint.

In connection with contact lenses and the length of time they can be worn safely, I have one ptaient who is now able to wear them for 14 hours at a time with no apparent interference with conjunctival circulation or corneal nourishment.

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EDITORS

DR. CAREL C. KOCH
1501 Foshay Tower
821 Marquette Avenue
Minneapolis, Minn.

DR. JACK I. KURTZ
1501 Foshay Tower
821 Marquette Avenue
Minneapolis, Minn.

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OPTOMETRY MAY LEARN SOME VALUABLE LESSONS FROM THE HISTORY OF MEDICINE

If one studies closely the history of the past he may be able to determine the course of future development. The teacher, the preacher, the statesman, the economist, the sociologist and the scientist all find that history holds an important lesson for them. This is equally true of all professions, especially is this true of the profession of optometry, which is one of the youngest. If we are to avoid the mistakes made by other professions we should turn to history, examine their past, and profit by their mistakes.

It seems that optometry is determined to follow a course, which may block its own progress, and prove detrimental to the successful development of the profession.

In view of the fact that optometry is trying to follow in the foot steps of medicine, it would be only proper that we try and examine some points in the history of medicine so that we may profit by its experience and avoid some of its mistakes. If we turn a page in the history of

medicine we find that some of the men who have made the greatest contribution to medicine, men whose discoveries revolutionized the practice of medicine, men whose names are considered as the pillars upon which the foundations of medicine rest were prosecuted, persecuted and ridiculed by every reactionary leader in the medical profession when they first advanced their ideas. There are many such cases recorded in history, too many to mention here, we shall therefore limit ourselves and only give a brief historical review of the trials and tribulations of one man—Louis Pasteur. For his great discoveries and contributions to medical science he was snubbed and persecuted during the latter part of the 19th century, and today he is honored as one of the greatest benefactors to mankind, and his theories and ideas are being taught in every medical school and his practices are being used by almost all physicians, clinics, and hospitals. Here are some of the facts about Pasteur as related by J. S. Holmes, Ph.D., Professor of Zoology in the University of California in his book: Louis Pasteur:

The Germ Theory and the Antiseptic

Pasteur was moved by the suffering of French troops not only from epidemics but from blood poison, gangrene, erysipelas and other involvements which accompanied wounds and operations. The mortality due to surgical operations was appalling. Hospitals were hot beds of infection and many hospitals had reputations that led them to be regarded as mere portals to death. Pasteur advanced the "Germ Theory" thus claiming that the germs (microbes) are responsible for the spread of infections after an operation. He therefore advised that everything used in an operation should be disinfected, the hands of the surgeon, instruments, bandages, and all other apparatus should be washed in carbolic acid, and at first, a fine spray should be sent out around the seat of the operation in order to kill the possible germs that might be floating in the air. The wounds were also washed out with the same solution. In short, he advocated that the "antiseptic method" be used during the operation. He was severely criticized by some members of the "Medical Academy" for his views on this subject. They claimed that he was a "mere chemist" and therefore his ideas in the field of medicine they claimed are to be given no consideration.

The stand pat reactionaries in the Academy of Medicine ridiculed Pasteur, his Germ Theory of diseases, and were definitely against the use of antiseptics. Dr. Peter was especially active and persistent in his attack. He contended that Pasteur, as a chemist, was inspired by the desire to be useful, and tried to reform medicine and change it from the "old" to the "new medicine." Dr. Peter predicted victory of the old medicine over the new fangled notions which were misleading so many of his colleagues.

Little did his critics then realize that they were dealing with the man whose discoveries with regard to disease were to be of greater value than those of all the academies in medicine in the history of the world.

Joseph Lister, an eminent surgeon in the University of Edinburgh, whose ideas about using antiseptic in surgery were similar to those of Pasteur was also severely criticized by the reactionaries for his extremely radical views, and for the employment of this curious procedure.

Today no medical practitioner would question the value of the use of antiseptic in surgery. It is accepted as a most important and necessary part in any operation.

Puerperal Fever

The death rate in Paris Maternity Hospital was appalling. The hospitals were considered as the worst possible places for bearing children. Pasteur discovered that certain microbes were the cause of the puerperal fever. The doctor himself, claimed Pasteur, is the cause of this epidemic because he and his staff carry the microbes from an infected woman to a healthy one. Some of the conservative members of the Academy claimed that it is impossible to find a microbe. The controversy in the Medical Academy was great. At an open meeting attended by medical students Pasteur despairing of his medical colleagues, addressed the students as follows: "Young men, you who sit on these benches, and who are perhaps the hope of the medical future of the country, do not come here to seek the excitement of polemics, but come and learn method."

Pasteur's discovery of the treatment and cure for hydrophobia was attacked by the reactionaries in medicine just as his microbe theory and his advice of using antiseptic.

Reports of Pasteur's discoveries and successes of his treatments spread to many different countries. The British government appointed a special commission to investigate fully his work, and the commission reported very favorably about his discoveries.

The commission found that there was a decline in mortality from surgical operations to one-tenth of the former rate before antiseptics were used. The death rate of child-bearing women decreased to less than one per cent, erysipelas and gangrene had almost entirely disappeared from hospitals in which they formerly ran riot. Pasteur's discovery of the treatment for hydrophobia was compared by the commission to that of vaccination against small pox. "It would be difficult to overestimate this discovery," claimed the commission.

Pasteur was Honored and Proclaimed a Great Public Benefactor

After the publication of the favorable reports by the English commission and those other countries about Pasteur's great work the opposition to him in medical circles began to diminish. As he approached his seventieth birthday a celebration was given in his honor. This celebration was initiated by several governments. It was held in the large theater of Sorbonne on December 27, 1892. It was presided over by the President of the Republic and it was attended by ambassadors and delegations of

many countries. There were also representatives of the Academy of Sciences and the Academy of Medicine.

The opening ceremonies presided over by M. Dupuy, Minister of Public Instruction, addressed Pasteur, recounting his great achievements and concluding in the following words: "Who can say at this hour how much human life owes to you, and what it will owe to you in the years to come? A day will come when some new Lucretius will sing in a new poem of nature the immortal master whose genius has engendered such great benefits. He will not picture him a solitary and unfeeling man as the Latin Poet has portrayed his hero: he will show him mingled with the life of his time, the sadness and joy of his country, dividing his life between the severe pleasures of scientific research and the sweet intercourse of family life, passing from his laboratory to his fireside, finding among his dear ones who knew him and who therefore loved him, the encouragement in daily work and comfort at all times, without which so many troubles would perhaps have diminished his ardor, checked his perseverance and enervated his genius. May France possess you for many years to come and show you to the world as a worthy recipient of her love, her gratitude, and her pride!"

A large engraved golden medal was then presented to Pasteur, and after a few words from M. Daubree, a former colleague of Pasteur's at Strasbourg, an address was made by Lord Lister, who was chosen with peculiar appropriateness as the representative of the Royal Societies of London and Edinburgh. "M. Pasteur," he said, "the great honor has been accorded me of bringing you the homage of the sciences of medicine and surgery. As a matter of fact, there is no one living in the entire world to whom the medical sciences owe so much as they do to you. Your researches in regard to fermentation have shed a powerful light that has illumined the fatal darkness of surgery and changed the treatment of wounds from a matter of empiricism, uncertain and too often disastrous, to scientific art of assured beneficience. Thanks to you, surgery has undergone a complete revolution which has robbed it of its terrors and extended its efficacious powers almost without limit. Medicine is indebted no less than surgery to your profound and philosophic studies. You have lifted the veil which for centuries had overhung infectious diseases. You have discovered and demonstrated their microbic nature. Thanks to your initiative and in many cases to your special and personal labors, there are already a number of these pernicious disorders of the causes of which we have a complete knowledge. . . .

"Infectious diseases constitute, as you know, the great majority of the maladies which afflict the human race. You can therefore well understand that the sciences of medicine and surgery are eager upon this solemn occasion to offer you the profound homage of their admiration and gratitude."

At the close of this address, the greeting of Pasteur and Lister, the two great figures in the creation of a great epoch in medicine and surgery, brought tumultuous applause. No one in that remarkable audience could ever forget the sight of these two men. The Academy of Medicine, the scene of so many controversies, paid its homage through its Dean, who said, "More fortunate than Harvey and Jenner, you have lived to see the triumph of your doctrines, and what a triumph!"

Comparing Optometry and Medicine Historically

If we now turn a page in the history of optometry we find that some of our present day leaders have seemingly learned nothing from the past; that some of these men still shut their eyes and minds to new teachings or ideas. For example, during the last two decades suggestions for developing optometry along broad professional lines have been made by a number of our leading practitioners and students in Optometry. Dr. Eugene Wiseman was one of the first men to point to the importance of building the practice of Optometry upon a broad professional base. Immediately the cry went up, "extra-ocular tests!" "We must keep away from them if we are to preserve Optometry as an independent profession." Yet, no honest person will today deny the fact that he (Wiseman) contributed more to the building of professional optometry than any other optometrist. His book "Building Optometry" will still stand as a pillar of professional Optometry after his critics will long be forgotten. His writings and teachings have been accepted by many optometrists and are today used as a routine part of their practice.

Another man who has contributed much to the professional development of Optometry is Samuel H. Robinson. He may be called the father of modern orthoptics, because by his research and his book "Oculo Prism Treatments," he placed the knowledge of those treatment techniques within the reach of every optometrist. He, too, has repeatedly advocated the development of optometry along broad professional lines, but the same cry of "extra-ocular" was sent up by the reactionaries objecting to his teachings. We may safely say that the influence Robinson brought to the development of professional optometry will be valued and remembered long after his critics have been forgotten.

We can go down the line and enumerate many more, but the names of these two leaders will suffice to illustrate our point.

The progressive ideas planted in the minds of optometrists by men like Wiseman, Robinson, Ryer, Spitler, Kraskin, Fitch, Tait, and others have been productive. These ideas have captuerd the imagination of the progressive elements in optometry. Some of the ideas and technics advanced by the broad minded leaders in optometry have passed beyond the stage of mere discussion, they have been actually adopted and incorporated in the practice of "Modern Optometry." Some of them have been incorporated in the recent optometry laws passed by the

several state legislators, and with the consent and cooperation of the organized medical groups. This should be an object lesson to those in Optometry who are suffering from a fear complex. They have often objected to optometrists applying physical or psychological agents such as high frequency, diathermy, synthonics, applied and abnormal psychology, because they claimed these may be properly claimed to be part of the field of medicine. That this contention is groundless can best be shown by a statement in this connection recently made by a leading medical scientist and practitioner which reads as follows: "Why should physical therapy and psychotherapy be considered as a part of medicine? Is it not true that my profession has been ridiculing all of its members who dared to use these technics in their practice? It has only been very recently that official medicine half-heartedly placed the stamp of approval upon the use of these technics in the medical practice. Also we must not forget that the Principles and Practice of Physical Therapy in Optometry was published prior to the publication of the Principles and Practice of Physical Therapy in Medicine, optometry certainly has priority claim." These words came from a medical man who is sincere and open-minded as are many of the members of that profession.

The lesson, for the reactionaries in Optometry should be plain. They should recognize their mistakes, and direct their activities along lines which will counteract the harm they have done in the past. They should do the same as some of the medical men did in the case of Pasteur. If they are not big enough to acknowledge their mistakes then the least they can do now is to refrain from placing stumbling blocks in the path of the more liberal and progressive leaders, who believe that optometry in 1936 can not and must not be practiced along the same lines it was practiced in 1906—in "the horse and buggy stage." Medicine and dentistry today are practiced differently than they had been practiced a third of a century ago. As the science advanced in each field, new methods and techniques were incorporated and applied in practice, in order that the public may get the advantage of these new scientific developments. This was accomplished in spite of the opposition and protest of the tories in these professions. Optometry must do likewise.

Jack I. Kurtz.

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BOOK NOTICES

1936 MID-WEST CONVENTION NOTES. H. L. Fuog, Opt.D. Published by Leo G. Miller, Opt.D., 603 Stuart Bldg., Lincoln, Nebr. 72 pages. Paper covers. $2.00. 1936.

This is a published report of a lecture on orthoptic treatment work presented before the various members of the Graduate Clinic Foundation

in meetings held in Colorado, Missouri, Oklahoma, Texas. Iowa, Minnesota, Nebraska, and North and South Dakota by Dr. Harry L. Foug of Los Angeles, California, who spent some time visiting these states during April of this year. The monograph is designed to appeal chiefly to those optometrists who are following the Clinic's routine of examination procedure and Foug's findings in the main agree with those usually found in Clinic's teachings. Foug urges that all optometrists pay greater attention to the innervational imbalances of the extra-ocular muscles and their relationship with accommodation and this is indeed good advice. Foug's monograph is followed with reprinted papers by Fording, Troland, Peckham and Horton, these being included in full by the publisher as they are referred to by Foug in his talk. The entire matter is well put together. C. C. K.

* * * * *

THE EYE AND ITS DISEASES: by 82 International Authorities. Edited by Conrad Berens, M.D., Ophthalmic Surgeon, Pathologist and Director of Research, New York Eye and Ear Infirmary, etc., etc. Published by the W. B. Saunders Company, Philadelphia, Pa. 1254 pages, 436 illustrations. Cloth. $12.00. 1936.

Here is as complete a treatise on ocular disorders as the writer has yet seen. Berens has followed a plan in arranging the material for this book that is frequently seen in medical texts on general diagnosis yet seldom seen in books limited to but a single specialty, the plan being to compile the material from some 82 of the leading English speaking ophthalmologists both here and abroad, and thus the reader benefits from both Berens' wide experience and also that of members of his profession who have developed special interests in phases of ocular work and who were willing to assist Berens in the monumental work of putting a text of this character together.

Viewing this work from the standpoint of the man whose chief interest lies in the field of ocular refraction we find the sections dealing with the embryology, anatomy and postnatal development of the eye very well done indeed. Also the chapters by Jackson and Evans dealing with the physiology of the eye and vision are equally fine, as is that portion of the work given over to refraction and accommodation. Particular reference must also be made here to the splendid chapter on diagnosis and treatment of errors of refraction by O'Rourke, while the sections on the extra ocular muscles by Peter, Verrijp and Pugh also merit attention.

The reviewer was also impressed by the splendid advice given refractionists in the chapter on routine examination of the eye and the symptomatology of eye diseases by Beach. This chapter should be read

and reread by every optometrist as Beach has done a fine piece of work in combining general physical diagnostic signs with those most frequently associated with ocular disorders.

The book in the main, of course, deals with the symptoms, diagnosis and treatment of ocular disease and here as in those sections already mentioned the authors cover their fields in a most thorough manner. Every phase of diagnostic procedure is reviewed and Berens and his contributors are to be commended for the outstanding text they have compiled. C. C. K.

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FUNDAMENTAL REFRACTION AND ORTHOPTICS. Louis Jaques, Opt.D., published by the author, 828 Pacific Mutual Bldg., Los Angeles, Calif. Illustrated. 209 pages. $6. Cloth. 1936.

In this book Jaques brings the reader his clinical experience in the field of refractive work. The book is written by a practicing optometrist, not as a treatise on physiological optics, but rather as a practical guide to the steps to be taken in making a thorough refraction. Each phase of the work is taken up in turn by the author and reviewed by him in some detail. Then his interpretations of the test is given as well as his views on just what values should be placed by the optometrist on the findings which were gotten. Jaques is one of the leading men in the Graduate Clinic movement, so obviously this monograph deals with refraction from that angle, yet the volume is one which will prove interesting and valuable to every optometrist. A short illustrated chapter is given over to a new near-point fixation device recently developed by Dr. J. F. Kothman which seems to have no little merit, and two very fine chapters on static and dynamic skiametry are included by that eminent Canadian optometrist Dr. Ivan S. Nott. Jaques as is well known, is the author and originator of the blur-point or blur-out-point techniques in testing accommodative reserves and covers these tests very thoroughly in this interesting new book of his. C. C. K.

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EYE, EAR, NOSE AND THROAT MANUAL FOR NURSES. Ray H. Parkinson, M.D. Third edition. Published by the C. V. Mosby Company, St. Louis, Mo. 232 pages, 72 illustrations. Cloth $2.25. 1936.

This little book by Parkinson was written with a view of furnishing nurses the necessary information in their work as assistants in eye, ear, nose and throat work. It is written in simple and clear style

and he gives many photographic illustrations of instruments, techniques both operative and treatment.

Three short chapters are devoted to the eye, namely: External ocular diseases: diseases of the refractive media of the eye and internal diseases of the eyeball. The author stresses the importance of using a cycloplegic in refracting children, he is apparently satisfied that in adults accurate refraction can be performed without the use of a cycloplegic. This is encouraging. The reviewer believes that with a little more investigation this author and others may come to the conclusion that it is also both possible and practical to refract children accurately without the use of a cycloplegic.

The book is well organized and illustrated and will serve the purpose for which it was written. —J. I. K.

* * * * *

THE RELATIONSHIP OF EYE MUSCLES TO SEMICIRCULAR CANAL CURRENTS IN ROTATIONALLY INDUCED NYSTAGMUS. John Favill, A.B., M.D., F.A.C.P. Clinical Professor of Neurology, University of Chicago. Privately printed by the Author. 48 pages. Illustrated. Cloth. Chicago, Illinois. 1936.

Favill develops his hypothesis on the assumption, that, (1) there is an endolymph movement, and (2) that this movement operates in such a manner as to bend the cupola and hair cells of a given crista toward or away from the canal to start the stimulus to some or all of the eye muscles, which are known to contract in the slow or vestibular component of a nystagmus. He reasons that, if consistent explanation of all types of rotationally induced nystagmus is obtainable, on this basis the assumption will appear to be justified. Favill also reasons that it is known that horizontal, rotary and vertical nystagmus can be induced in both eyes, when only one labyrinth is functioning and he, therefore, approaches this problem, by first studying the phenomena of one labyrinth alone, first, with the patient's head held in a horizontal position, then with it in a vertical position and finally when rotary nystagmus is being produced.

The author then reviews a number of experiments he has conducted and comes to the following conclusions: (1) A possible definite relationship of semicircular canal currents to eye muscle actions in nystagmus induced by rotation has been considered possible for years. (2) The total number of possible currents or combinations of currents in one labyrinth is twenty-six. (3) Fourteen current pictures account for the known types of induced nystagmus. (4) Twelve current pictures remain. (5) Calculations were made as to how to produce these by rotation and what eye movements would then result. (6) Experiments with one normal man showed the results as predicted. (7) The endolymph movement theory and the author's crista-muscle assignment are thus upheld in rotationally induced nystagmus.

—C. C. K.